

# The Effects of Changes to IEEE 519-1992 to 2014

## Introduction

Recent changes have been made to IEEE 519. These revisions add clarity to the 1992 document as well as present new definitions, methods and recommendations. This brief summary of changes to IEEE 519 as it pertains to low voltage adjustable frequency drives (AFD's) is further expanded on in the following pages. This paper is not an exhaustive analysis of the differences between the 1992 version and the 2014 version. Rather, it attempts to highlight the differences as they affect the practice of specifying, applying and installing low voltage adjustable frequency drives.

1. The Point of Common Coupling (PCC) is specifically defined as the point of connection to the utility.
2. Total Demand Distortion (TDD) is redefined. TDD is the critical base which determines how % harmonics are to be limited. The new definition attempts to clearly establish what had previously been open to interpretation.
3. A new statistical method of measuring and recording harmonic content is described with a greater emphasis on statistical sampling and almost no mention of instrumentation.
4. Revised voltage distortion limits are established.
5. No changes were made to the current distortion limits, however the new table ignores harmonics above the 50<sup>th</sup>.
6. The recommendations for increasing harmonic current limits put active and passive filters on an equal footing with phase shifted multipulse drives.



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<b>Topic</b>	<b>IEEE 519 – 1992</b>	<b>IEEE 519 – 2014</b>	<b>What it means</b>
<p>Point of Common Coupling (PCC) Definition</p>	<p>“The recommendation described in this document attempts to reduce the harmonic effects at any point in the entire system by establishing limits on certain harmonic indices (currents and voltages) at the point of common coupling (PCC), a point of metering, or any point as long as both the utility and the consumer can either access the point for direct measurement of the harmonic indices meaningful to both or can estimate the harmonic indices at point of interference (POI) through mutually agreeable methods. Within an industrial plant, the PCC is the point between the nonlinear load and other loads” <sup>(1)</sup></p>	<p>“The limits in this recommended practice are intended for application at a point of common coupling (PCC) between the system owner or operator and a user, the PCC is usually taken as the point in the power system closest to the user where the system owner or operator could offer service to another user. Frequently for service to industrial users (i.e., manufacturing plants) via a dedicated service transformer, the PCC is at the HV side of the transformer. For commercial users (office parks, shopping malls, etc.) supplied through a common service transformer, the PCC is commonly at the LV side of the service transformer.” <sup>(2)</sup></p>	<p>Project specifications which require harmonic limits at locations within their plant that don't conform to the new PCC definition can no longer identify this requirement as conforming to the IEEE-519. However, IEEE-519 is not an enforceable code in and of itself. The intent of the specifying party still needs to be considered.</p>
<p>Total Demand Distortion (TDD) Definition</p>	<p>“Total demand distortion (RSS), harmonic current distortion in % of maximum demand load current (15 or 30 min demand)” <sup>(3)</sup></p>	<p>“The ratio of the root mean square of the harmonic content, considering harmonic components up to the 50th order and specifically excluding interharmonics, expressed as a percent of the maximum demand current. Harmonic components of order greater than 50 may be included when necessary.” <sup>(4)</sup></p>	<p>TDD is the critical base which determines how % harmonics are to be limited. The new definition attempts to clearly articulate what had previously been open to interpretation.</p>
<p>Harmonic Measurement Methods</p>	<p>“9.2 Basic Equipment Used for the Analysis of Nonsinusoidal Voltages and Current” This section describes the instrumentation and techniques required to accurately measure industrial harmonics. <sup>(5)</sup></p>	<p>The new requirement for Harmonic Measurements Methods include well defined “very short time harmonic measurements”, “short time harmonic measurements”, and “statistical evaluation techniques.” These techniques reduce the effect of outlier data points. <sup>(6)</sup></p>	<p>The 2014 recommendation emphasizes statistical analysis over instrumentation. This will have little effect on the planning of new AFD's but will impact on site measurements.</p>

Topic	IEEE 519 – 1992	IEEE 519 – 2014	What it means
Voltage Distortion Limits	“Table 10.2 – Low-Voltage Systems Classification and Distortion Limits” establishes three levels of allowable voltage distortion (THD) based on the system classification; Special 3%, General 5% and Dedicated 10% <sup>(7)</sup>	“Table 1 – Voltage distortion limits” establishes limits dependent on the bus voltage at the PCC. It ranges from 8% at $V \leq 1.0$ kV, to 1.5% at $161$ kV $< V$ . <sup>(8)</sup>	These are very different approaches. The 2014 approach emphasizes the utility perspective above that of the installation.
Maximum Harmonic Current Distortion in Percent of IL	For low voltage and medium voltage drives use “Table 10.3 - Current Distortion Limits for General Distribution Systems (120 V Through 69,000 V)” <sup>(9)</sup>	For low voltage and medium voltage drives use “Table 2 – Current distortion limits for systems rated 120V through 69kV” <sup>(10)</sup>	The two tables have identical entries, however 1992 specifies harmonic numbers $> 35$ th while 2014 specifies $35 \leq h \leq 50$ . The 2014 table makes it clear that harmonics greater than the 50 <sup>th</sup> are not addressed by this recommendation.
Recommendations for Increasing Harmonic Current Limits	“However, when phase shift transformers or converters with pulse number ( $q$ ) higher than six are used, the limits for the characteristic harmonic orders are increased by a factor equal to $\sqrt{q/6}$ provided that the amplitudes of the noncharacteristic harmonic orders are less than 25% of the limits specified in the tables.” <sup>(11)</sup>	“It is recommended that the values given in Table 2, Table 3, and Table 4 be increased by a multiplying factor when actions are taken by a user to reduce lower-order harmonics. The multipliers given in table 5 are applicable when steps are taken to reduce the harmonic orders given in the first column.” <sup>(12)</sup>	This change puts alternate mitigation techniques (passive filters, active filters) on an equal footing with phase shift transformers with higher pulse converters.

## References

- <sup>[1]</sup> Section 10.1 – Pg. 75 of IEEE 519-1992
- <sup>[2]</sup> Section 1.2 – Pg. 2 of IEEE 519-2014
- <sup>[3]</sup> Section 3.1 – Pg. 11 of IEEE 519-1992
- <sup>[4]</sup> Section 3 – Pg. 4 of IEEE 519-2014
- <sup>[5]</sup> Section 9 – Pgs. 68-74 of IEEE 519-1992
- <sup>[6]</sup> Section 4 – Pg. 4-5 of IEEE 519-2014
- <sup>[7]</sup> Section 10.3 – Pg. 77 of IEEE 519-1992
- <sup>[8]</sup> Section 5.1 – Pg. 6 of IEEE 519-2014
- <sup>[9]</sup> Section 10.3 – Pg. 78 of IEEE 519-1992
- <sup>[10]</sup> Section 5.2 – Pg. 7 of IEEE 519-2014
- <sup>[11]</sup> Section 10.4 – Pgs. 78 of IEEE 519-1992
- <sup>[12]</sup> Section 5.5 – Pg. 9 of IEEE 519-2014

## Additional Help

In the US or Canada: please contact the Technical Resource Center at 1-877-ETN-CARE or 1-877-326-2273 option 2, option 6.

All other supporting documentation is located on the Eaton web site at [www.eaton.com/Drives](http://www.eaton.com/Drives)

